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Deployment of Climate Change Adaptation Technologies

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Introduction

Developing countries are seriously impacted by climate change. The World's 55 most climate-vulnerable have already lost 20% of their GDP.[1] Achieving the long-term goals of the 2015 Paris Agreement [2] to tackle climate change adaptation would require both new and emerging technologies as well as innovative business models and markets for their successful deployment at scale in developing countries.

Climate change adaptation means taking action to prepare for and adjust to the current and projected impacts of climate change. With climate change bringing more frequent and intense extreme weather events such as heatwaves, droughts and floods, individuals and communities can reduce their vulnerability and increase their resilience by adapting now.[3]

To adequately address climate adaptation game changers, emerging adaptation technologies will need to be cost-effective, environmentally sustainable, and socially acceptable while responding to the uncertainties of climate change adaptation. On the other hand, the success of technology research, development and demonstration (RD&D), transfer and diffusion will depend on speed, enabling policy and regulatory set up, capacities to absorb, deploy and improve the technologies appropriate to local circumstances, finance and investment. [4]

Currently, the development of disruptive technologies at scale for adaptation is lagging far behind those for mitigation for effective deployment at scale. Numerous factors are responsible for the limited success of traditional RD&D programs in the climate change adaptation and for discouraging private sector investments.

Promising technologies such advanced artificial intelligence (AAI) and machine learning for adaptation, evapotranspiration optimization, urban heat island management, climate intervention

[1] https://www.v-20.org/wp-content/uploads/2022/06/Climate-Vulnerable-Economies-Loss-Report_June-14_compressed-1.pdf
[2] https://unfccc.int/process-and-meetings/the-paris-agreement
[3] https://gca.org/what-is-climate-adaptation/
[4] https://www.whitehouse.gov/wp-content/uploads/2024/07/Climate-Resilience-Game-Changers-Assessment.pdf

technologies and many others currently receive less support despite their potential.

This policy note provides an overview of adaptation challenges, finance and the most important macro-barriers that need to be overcome to increase the effectiveness of adaptation RD&D. It should be noted, however, that in addition to the barriers discussed here, numerous other context-specific micro-level barriers hamper the development, transfer, and diffusion of new technologies, especially in developing countries.

Adaptation Finance

Climate financing so far has been insufficient to address the the challenges confronting developing countries. Developing countries especially will be hard pressed to meet the anticipated investment need of hundreds of billions per year to bridge the adaptation funding gap. A climate resilient financing pathway offers a significant investment opportunity for developing countries with a triple dividend of avoided losses, positive economic gains, and enhanced social and environmental benefits.

The United Nations Environment Programme (UNEP) Adaptation Gap Report estimates global investment needs in adaptation in developing countries at around $300 billion annually by 2030 and this number is projected to increase, in addition to climate change mitigation efforts.[5]

Globally, an average annual commitment of USD 653 billion in climate finance was committed in 2019-2020. An average of USD 49 billion was dedicated specifically for adaptation finance, representing around 7% of total finance. The public sector contributed USD 48 billion of total adaptation funding (97%). Within this sector type, multilateral Development Financial Institutions (DFIs) represented the most significant source of adaptation finance flows (USD 17 billion, or 35% of the total), followed closely by national DFIs (USD 15.5 billion, or 30% of the total). Bilateral DFIs and governments also represented a considerable contribution, providing USD 7 billion (14%) and USD 6 billion (12%) respectively.[6] The private sector contributed USD 1 billion of the total adaptation finance (2%).

Unpacking adaptation finance needs remains a challenge. In recent years public sector and DFIs aimed at balancing investments in adaptation versus mitigation. On the other hand, the majority of private sector finance is still targeted towards mitigation, indicating a need to create an enabling environment and bring in more innovation and new technologies for adaptation to scale up private investments in adaptation. However, even with increased adaptation funding, learning and prioritization will be essential to improve efficient use of resources.

Emerging technologies

According to the World Economic Forum, six technologies are critical for climate adaptation. These are artificial intelligence, drones, Earth observation, advanced computing, the Internet of Things and virtual and augmented reality.[7] These emerging technologies are new, cutting edge, innovative, and often disruptive technologies. They offer many innovative applications to address the challenges of

[5] https://www.unep.org/resources/adaptation-gap-report-2022
[6] https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-a-decade-of-data/
[7] https://www.weforum.org/agenda/2024/02/ai-climate-adaptation-technologies/#:~:text=Six%20technologies%20are%20critical%20for,and%20virtual%20and%20augmented%20reality.

climate change adaptation across various sectors. These technologies can be key enablers of sustainability and environmental resilience – offering important opportunities to help assess, and adapt to climate change. For example, early warning systems powered by Earth observation and drones can help save lives in climate disasters.

According to the World Bank Group, Investors and policymakers are realizing the immense potential of new technologies for climate adaptation, and innovative solutions and business models are being scaled across sectors, from transport and agriculture to water etc. The challenge, however, is that this kind of breakthrough technologies – also known as deep tech – involve exceptionally complex research and development processes, in addition to the right revenue model to scale – unlike startups in digital or software-based sectors, the path to scale for deep tech companies takes longer and requires patient risk capital.

Barriers to technology access

The main question in mind is how and who can access these technologies? Looking at analysis of patent data done by the World Bank[8], there is a clear gap between where adaptation technologies are developed and where the technologies are needed the most, with most development happening in the developed countries and China. China, Germany, Japan, the Republic of Korea, and the United States together account for nearly two-thirds of all high-value adaptation inventions. Developed countries are leading the way when it comes to innovation, but many countries are also performing above expectation relative to their level of economic development, with India, Kenya and Vietnam standing out.

Countries could import technologies from other countries through trade agreements, partnerships and technology transfer. Compared to technologies that help reduce greenhouse gas emissions, according to the World Bank, few climate adaptation inventions are transferred and most often they are transferred between high-income countries.[9] In addition, climate technologies are not always affordable or accessible on time to developing countries and in particular climate-vulnerable people. In fact, emerging market and developing economies rely much more on foreign than homegrown research (basic and applied) for innovation.[10] According to the IMF, in countries where education systems are strong and financial markets deep, the estimated effect of foreign technology adoption is particularly large.[11]

While many adaptation technologies can be applied in all countries regardless of their conditions, other technologies must be adapted to local circumstances. Technologies to be adapted include end-use

[8] Dechezlepretre,Antoine; Fankhauser,Sam; Glachant,Matthieu Michel Marcel; Stoever,Jana; Touboul,Simon. *Invention and Global Diffusion of Technologies for Climate Change Adaptation : A Patent Analysis (English).* Washington, D.C. : World Bank Group.http://documents.worldbank.org/curated/en/648341591630145546/Invention-and-Global-Diffusion-of-Technologies-for-Climate-Change-Adaptation-A-Patent-Analysis
https://documents1.worldbank.org/curated/en/648341591630145546/pdf/Invention-and-Global-Diffusion-of-Technologies-for-Climate-Change-Adaptation-A-Patent-Analysis.pdf

[9] https://documents1.worldbank.org/curated/en/648341591630145546/pdf/Invention-and-Global-Diffusion-of-Technologies-for-Climate-Change-Adaptation-A-Patent-Analysis.pdf

[10]https://www.researchgate.net/publication/351007922_Innovation_in_and_from_emerging_economies_New_insights_and_lessons_for_international_business_research

[11] https://www.imf.org/en/Blogs/Articles/2021/10/06/blog-ch3-weo-why-basic-science-matters-for-economic-growth

technologies suited to local consumption patterns, technologies to operate in the absence of a strong operations and maintenance support network, and resource mapping for hot spot sources.

The vast majority of resources and expertise for technical innovation are in the OECD countries, which are rarely motivated to develop products suited solely for the poorer countries. OECD governments will naturally primarily promote research that serves their own citizens and economies. Similarly, private industry often regards markets in developing countries as less attractive due to lower capacity to pay, higher transaction costs, weaker contract law and intellectual property rights, and general unfamiliarity.

The amount of R&D in any field is affected by the strength of intellectual property right (IPR) protection. Companies that invest heavily to develop new technologies must be guaranteed the benefits of their innovations. In most OECD countries, IPR protection is sufficient and although not perfectly flawless on an international basis this protection generally works well among countries within the industrialized world. However, the fear of substantially weaker IPR protection in many developing countries—and the corollary threat of technology theft—deters investment in this field.

For some adaptation technologies, for which sophisticated technological advances and large sums of capital are required, this factor is particularly relevant. Strong IPR can improve incentives to develop such technologies. Yet, strong IPRs deter the adoption and diffusion of new technologies once they are commercialized.

Adaptation technologies could be costly, but they could help avoid larger losses in the future. With loss and damage high up on the climate agenda enabled tech solutions could potentially help to prevent USD 66 billion in loss and damage annually.[12]

The economic rationale for investing in climate adaptation is strong. Benefit-cost ratios range from 2:1 to 10:1.[13] Yet, money is not flowing at the pace or scale needed and there is a need to shift the way investment decisions are made to account for climate risks, scaling disaster risk finance and insurance, as well as harnessing private capital for resilience. noting that currently, only 1.6% of all adaptation funding comes from the private sector [14]

The "Valley of Death" between Public and Private-Sector Development

Reduced risk appetite among private investors in adaptation makes it harder to finance and test the new technologies, products and services needed to transition towards resilient economic growth pathways. However, large-scale adaptation efforts by the private sectors in particular are needed. This requires to invest in technology adaptation in sectors including water, agriculture and crop production, fisheries and aquaculture, forestry and biodiversity, health and infrastructure. According to the World Economic Forum, adaptation efforts will generate demand for products and services

[12] https://www.preventionweb.net/news/roadmap-managing-disasters-2-how-climate-vulnerable-countries-can-use-tech
[13] https://gca.org/programs/climate-finance/
[14] https://openknowledge.worldbank.org/server/api/core/bitstreams/127de8c7-d367-59ac-9e54-27ee52c744aa/content

and open new markets – all of which can help businesses generate revenue and achieve efficiency while contributing to the resilience of ecosystems and communities. [15]

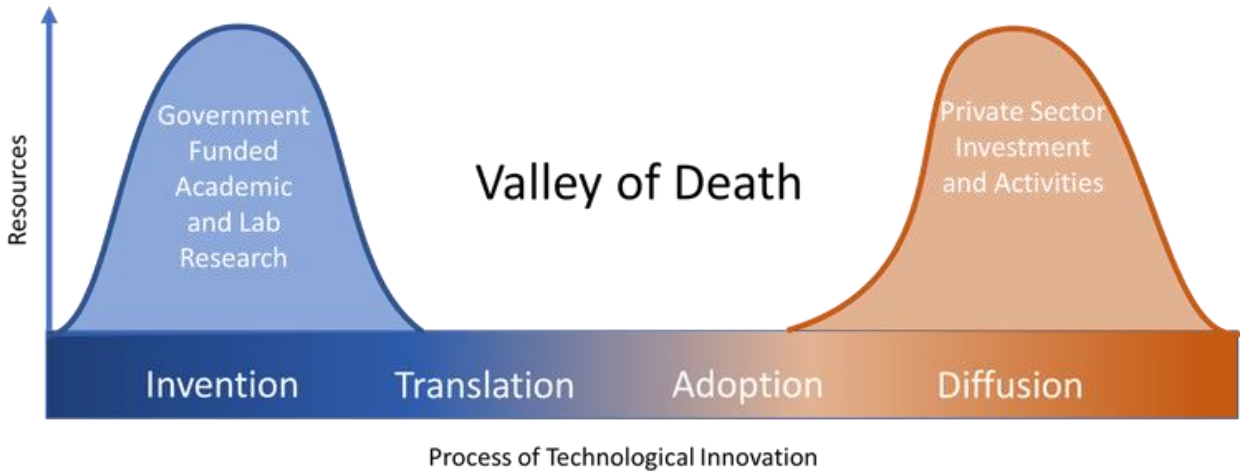
There is no reliable valuation for the primary products and technologies that climate change adaptation products deliver. Consequently, so far, the private sector has shown little incentive to develop and disseminate at scale adaptation technologies. On the other hand, adaptation efforts and technology development will be too expensive for governments and organizations to take on alone. Resource constraints will only become worse as risks become more acute. This will hinder adaptation efforts and diminish the ability of governments to provide the essential services needed for a functioning society.

The public and private sectors both play important roles in adaptation technology commercialization. The public sector normally begins the process with basic scientific research, often without specific end-products in mind. Much of this research is lab-based and involves high risks with potentially high return with great uncertainty of the impacts. As technical challenges are overcome and product ideas appear with profit potential, the private sector becomes increasingly involved. The risk is still high—as are the potential returns—at this stage but the products under development are now much closer to commercial application.[16]

The "valley of death" refers to the period in product development between public and private sector involvement (see Figure 1). The major technical problems have been solved in the lab and one or more potentially profitable products have been identified but still requires significant development to operate in real-life settings. At this point, public-sector participation usually declines as the government backs away from "picking winners." The private sector usually does not invest in a discovery that's only achieved proof-of-concept because there is still too much risk to justify the expense. Furthermore, governments do not want to subsidize private industry or distort the market because investors stand to profit handsomely from the ultimately commercial products. However, the private sector often still sees too much risk to get fully involved and to continue the product development process on its own; promising technologies do not progress to the demonstration and scale- up stages needed to achieve full commercialization. Although many technologies do eventually make it through this period—either through additional public, private, or combined efforts—this gap seriously delays commercialization and prohibits the rapid deployment of adaptation options in the urgent time frame needed.

[15] https://www3.weforum.org/docs/WEF_Climate_Change_Adaptation_2023.pdf
[16] https://documents.worldbank.org/en/publication/documents-reports/documentdetail/617271468140972636/accelerating-clean-energy-technology-research-development-and-deployment-lessons-from-non-energy-sectors

Figure 1. Public and Private Sector Development: The Valley of Death



Source: Jetta Wong/Information Technology & Innovation Foundation, CC BY-SA

Policy recommendations for efficient adaptation

There are several key actions and policy recommendations when it comes to adaptation ambition:

- Adaptation is a dynamic process. We should not think of adaptation as a one-time adjustment because climate will continue to change this century and beyond. Adaptation as a process should start now because we know that climate has changed and will continue to change. Promoting efficient adaptation to existing weather can be a practical way to start for all countries.

- Adaptation needs to be undertaken by both governments and the private sector. Governments should prioritize adaptation investments with positive externalities, while creating a playing field that allows for private sector adaptation by removing market imperfections and easing policies. Fiscal policy has an important role to play through incentives, infrastructure investment, resilient financing plans, and regulations that address market imperfections.

- Adaptation should be integrated in policy frameworks and development planning. Governments should develop macro-frameworks that reflect climate risks and address adaptation spending needs with adequate and robust financing sources. In addition, there is a need to mainstream in Governments macro-frameworks, the macro-economic aspects of climate change in surveillance and integrate climate, including adaptation.

- Adaptation is costly and potentially unaffordable for some countries. The UNEP estimates global investment needs in adaptation at around $300 billion annually in 2030 and this number is

projected to increase. While the global average for public adaptation needs seems manageable, it can quickly escalate for smaller countries and exceed 100 percent of GDP. In such cases, while adaptation spending is critical to reduce climate-vulnerabilities; undertaking investments could exacerbate debt vulnerabilities.

- There are some adaptation measures that can deliver quick gains. "Low-cost-high-impact" investments that countries could undertake include early warning systems. Changing building codes would greatly reduce future adaptation costs. Equally, there are measures where reaping the full benefits will take time, capacity building, and funding, such as developing heat- and drought-resistant crops—R&D in these areas need to be incentivized.

- Financing the implementation of new climate adaptation technologies poses a novel challenge for many financiers, as it does not neatly align with traditional venture capital structures. The capital requirements for these climate technologies are typically much higher and profits are made over a longer time period.

- Financial flows for adaptation need to increase from the current low levels. There is a clear need to address the bottlenecks in international climate finance architecture to allow for increased financing to climate-vulnerable countries, particularly low-income countries. Good climate budgeting frameworks can facilitate access to climate finance. Most of climate financing is in the form of loans. There is a need to mobilize more grants and concessional financing.

- The private sector needs to play its part too. The Global Commission on Adaptation [17] estimates suggest the private sector is currently only allocating around US$500 million towards adaptation spending—a small share of the overall need. Financial markets, and sustainable finance in particular, will have to play an important role in filling the financing gap through accelerated utilization of global infrastructure development facilities (e.g., The Global Infrastructure Facility,The Multilateral Cooperation Center for Development Finance) and applicable climate finance instruments that support de- risking of finance (e.g., green public funds, blended finance, guarantee facilities, public-private partnerships/PPP). Additionally, increased insurance coverage can help reduce the adverse effects of climatic disasters. Unlocking the potential of the financial sector requires strengthening the climate information architecture—to facilitate the pricing of climate-change-related risks, support sustainable finance markets, and enable regulators gauge system-wide risks.

- Innovative instruments such as debt for climate swaps (DS) and biodiversity finance can be leveraged to mobilize more resources for adaptation. It could reduce debt burdens, particularly in developing countries with high external public debt, and direct funds to adaptation, conservation or restoration in these countries to create employment.

[17] https://gca.org/wp-content/uploads/2019/09/GlobalCommission_Report_FINAL.pdf

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